Industrial Applicability

The pump of suggested design might be successfully used, in particular, in systems of water intake, in oil and gas producing branches of industry, in mining, etc., with the purpose to lift stratal liquids and gas-liquid mixtures with increased gas content from boreholes.

Claim

We claim a multistage submersible axial-flow pump. This pump contains axial stages arranged sequentially on the shaft inside casing. Each of these stages contains guide vanes and a hub-shaped impeller. The diameter of the impeller hub d_{hub} at the impeller inlet equals to

$$d_{hub} = D_{extimp} \times \sqrt{1 - \left[\frac{K_D}{D_{extimp}} \times \left(\frac{Q}{60n} \right)^{1/3} \right]^2},$$

where $D_{ext\ imp}$ – external diameter of impeller, m;

$K_D = 3.2 \div 4.5$ – factor of impeller diameter;

Q – capacity of pump, m^3/s;

n – rotational speed.

The end washers are fixed at the face surfaces of the hub and are made of antifriction wearproof material. The blades are arranged at lateral surface of the hub along the helical line with the lead of helix of

$$S = \frac{\pi \times D_{extimp} \times (1 + \bar{d}_{hub})}{2} \times tg \left[2 \times acrtg \left(\frac{480 \times Q}{\pi^2 \times D_{extimp}^3 \times n \times [1 + \bar{d}_{hub}] \times [1 - \bar{d}_{hub}^2]} \right) \right],$$

where $\overline{d}_{hub} = \dfrac{d_{hub}}{D_{extimp}}$ – hub ratio at the impeller inlet.

The inlet edges of blades are rounded, the inclination angle of blades relative to the face surfaces of the hub obey the law

$$\beta_{bl}(r_i) = arctg\left(\frac{S}{2 \times \pi \times r_i}\right),$$

where $\beta_{bl}(r_i)$ – inclination angle of blades at the radius r_i;

S – lead of helix;

r_i – radius measured from the impeller axis till the current point at the blade surface.

Density $\tau_{ext\ imp}$ of blade lattice at the external diameter has the value of

$$\tau_{extimp} = \frac{l_{extimp} \times z_{imp}}{\pi \times D_{extimp}} = 0.7 \div 1.3,$$

where $l_{ext\ imp}$ – blade length at the external diameter;

z_{imp} – number of blades.

Each stator guide vanes contain a hub with two end shoulders at their face surfaces. The radial vanes are installed at lateral surface of the hub along the direction parallel to stage axis. Both inlet and outlet edges of vanes are rounded. Density $\tau_{av\ gv}$ of circular vane lattice at the middle diameter $D_{av\ gv}$ has the value of

$$\tau_{av\,gv} = \frac{l_{gv} \times z_{gv}}{\pi \times D_{av\,gv}} = 0.8 \div 1.6,$$

where $l_{ext\,imp}$ – vane length;

z_{imp} – number of vanes.